A Convective-Stratiform Rainfall Classifier for Composite Radar Reflectivity Maps

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The objective of this study is to develop an algorithm to characterize rainfall fields from a multiyear data base of high spatial and temporal resolution radar reflectivity measurements. The radar reflectivity data product, referred to as NOWRAD, is composited in real-time from the U.S. National Weather Service network of WSR–57, WSR–74 and WSR88–D radars and provided to us by Weather Services, Inc. The spatial resolution of each pixel is 2 km across the United States with a temporal resolution of 15 min.

The individual images are classified into convective and stratiform rainfall components. The integration of the 96 images received each day yields a daily rainfall estimate. Daily rainfall estimates are next integrated into monthly and seasonal estimates. These data sets are then to be used to examine the natural variability of rainfall in the United States from year to year during the period 1994 through 1996. Convective and stratiform rainfall regions are identified and then partitioned into convective and stratiform rainfall using two Z-R relationships.

A training data set using 10 days in April 1994 was used to develop and test the methodology. Two case studies were then examined from rainfall episodes on April 11, 1994, and April 21 and 22, 1994, within the Arkansas-Red River Basin to assess the algorithm performance. The first objective was to establish a threshold function to select convective centers. Next, the gradient between each pixel and its neighbors was computed to isolate these centers. The neighborhood reflectivity was specified to be the linear average of nonzero reflectivities, Z, in a 100 km^2 region centered at any pixel. Finally, the rainrate, R, in convective and stratiform rain areas is performed with $Z=300R^{1.4}$ applied to the convective areas and $Z=200R^{1.6}$ applied to the remaining rain areas.

Figure 158 shows the basin domain and reflectivity observed at 2,330 UTC on April 21, 1994. Figure 159 shows the area-averaged hourly rainfall estimates derived from the NOWRAD (NRD) data for the entire month, and separated into convective (CNV) and stratiform (STR) components. These estimtes are compared with the NWS

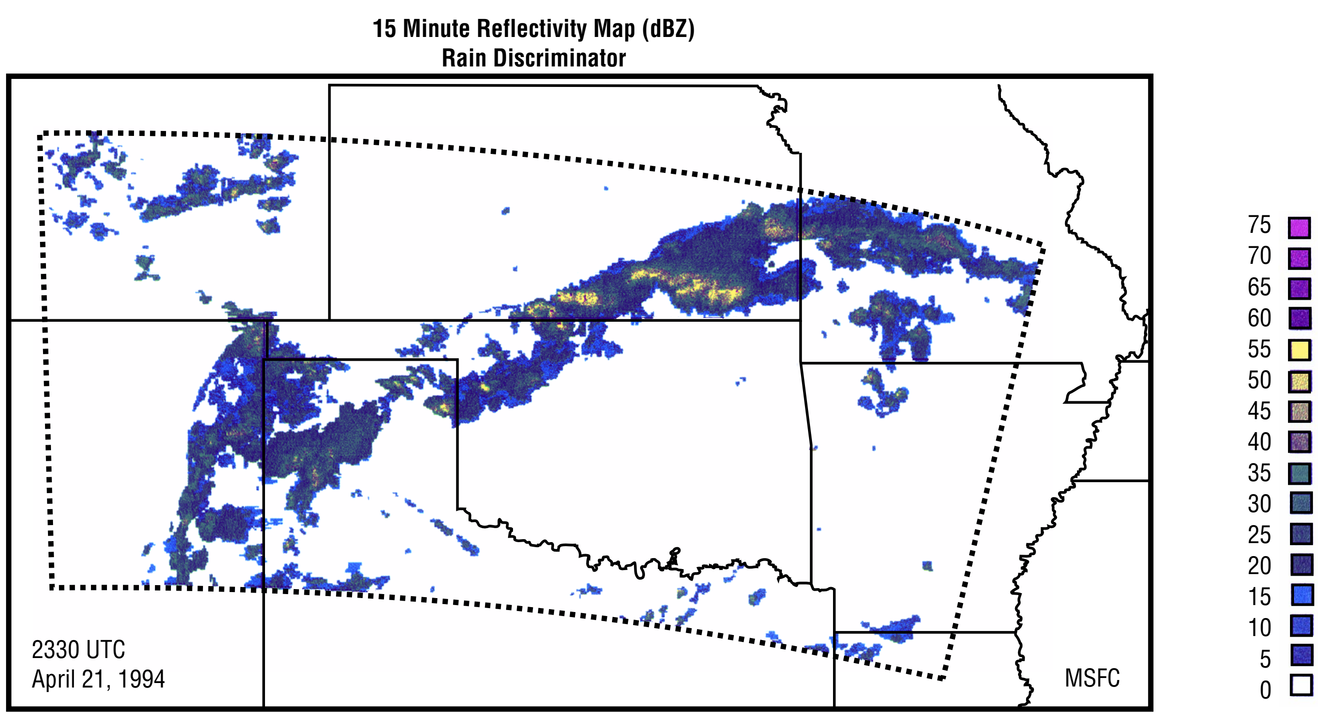

FIGURE 158.—NOWRAD composite reflectivity for the Red River Basin domain at 2,300 UTC on August 21, 1994. The area enclosed by the dotted line represents the basin.

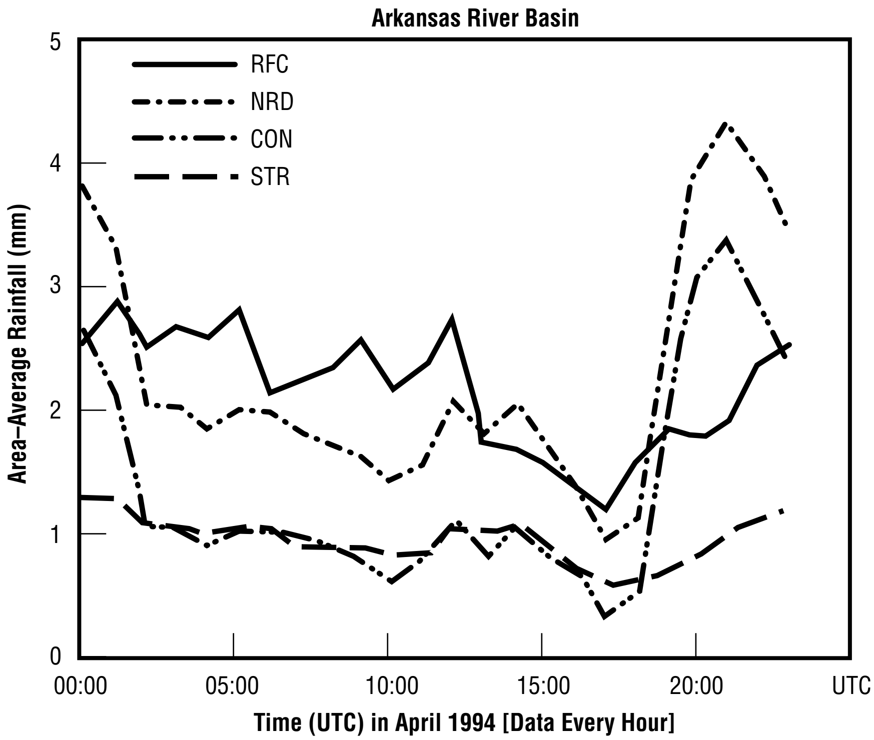

FIGURE 159.—Area-averaged hourly rainfall for April 1994 over the Red River Basin.

Stage-III River Forecast Center (RFC) rainfall estimates during the same time period. The hourly RFC estimates are derived from raingage-adjusted WSR88-D reflectivity fields. The trends in both estimates are similar and the differences over the basin are a few millimeters per day (fig. 160).

Our initial attempt at classifying rainfall over one large river basin on a monthly time period is promising. Our 28-day sample data set for April shows low RMSE values of 0.12 mm (or 45 percent of the Stage-III area-averaged hourly mean rainfall) with a bias of 0.01 mm. It appears that the methodology should produce sufficiently accurate estimates of rainfall over large spatial domains and over multiyear time periods to characterize the year-to-year differences in rainfall. These rainfall distributions and characterizations can be used by MTPE scientists as input or validations to regional modeling experiments to learn more about the seasonal-to-interannual behavior of rainfall and its response to larger scale atmospheric forcing. This data base may also be of use in recomputing extreme rainfall statistics for improved water management models and decision aids.

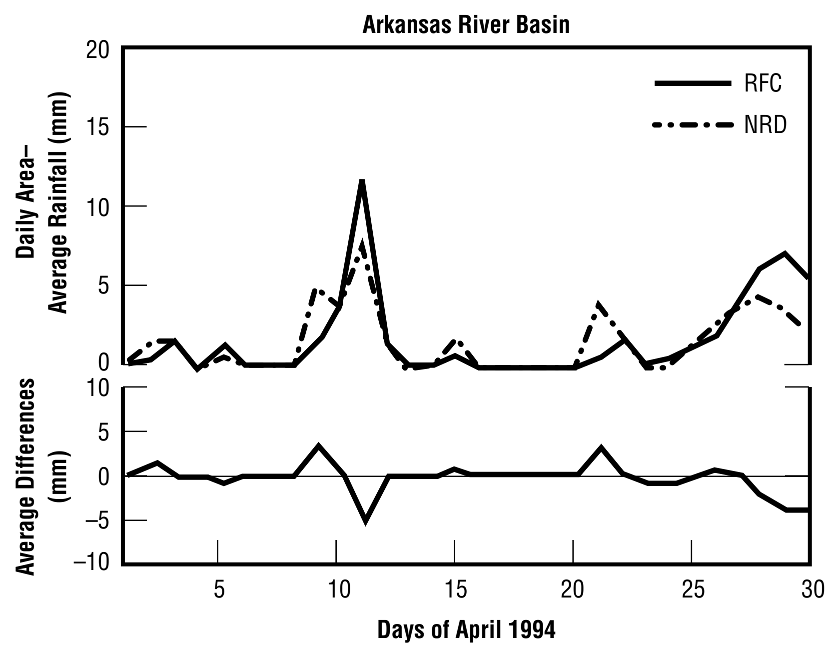

FIGURE 160.—Daily area-averaged rainfall over the Red River Basin for April 1994. The difference between the Stage-III (RFC) and the NOWRAD (NRD) estimates is also shown.

Crosson, W.L.; Duchon, C.E.; Raghavan, R.; Goodman, S.J.: "Assessment of Rainfall Estimates Using a Standard Z-R Relationship and the Probability Matching Method Applied to Composite Radar Data in Central Florida." *Journal of Applied Meteorology*, 35, pp. 1203–1219, 1996.

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Biographical Sketch: Dr. Steven Goodman is an atmospheric physicist within the Space Sciences Laboratory of the MSFC Science and Engineering Directorate and the Global Hydrology and Climate Center. His research interests are in cloud precipitation and electrification processes and their regional, global, and interannual variability. He serves as a member of the EOS lightning imaging sensor instrument team and as the project scientist for the LIS science computing facility. Dr. Goodman has a B.A. in atmospheric and oceanic science, an M.S. in atmospheric science, and a Ph.D. in systems engineering. He has been with MSFC since 1981.